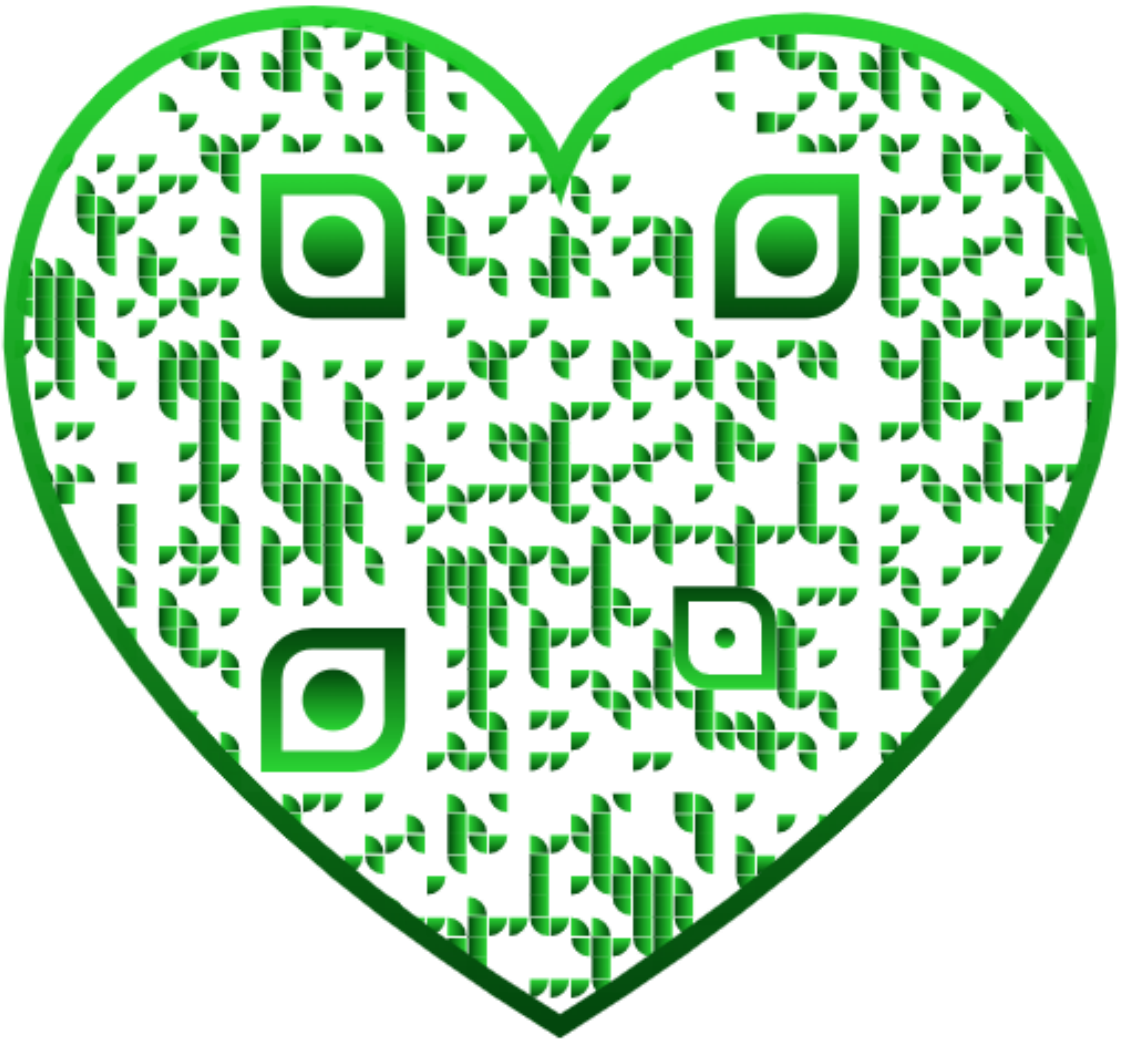
Draw Pharmacology in your mind

If you are a pharmacy student
If you are postgraduate and want to revise pharmacology by an easy way
If you are using any pharmacology reference
this file will aid you
> And wait for more <

Follow me at
Pharmacistalaanasr.wordpress.com
Contact me at
Pharm.alaa@gmail.com

لا تنسونى من صالح دعائكم

Pharmacist. **Alaa Nasr** د. آلاء نصر



Brain

Cerebrum

- The largest part of the brain
- Composed of 2 cerebral hemispheres
- The outer layer is cerebral cortex
- **Contains:**

1. **Motor area** (*controls voluntary movements*)
2. **Sensory areas** (*control sensation*)
3. **Association areas** (*controls higher mental activities such as consciousness, memory, behavior, learning .. etc*)

- Deep in the cerebrum is located the **basal ganglia** which include (Corpus striatum + Substantia negra) (***keep in mind*** *if damaged → parkinson's disease*)

Forebrain

Thalamus

- **Sensory integrating center**
- Receives sensory impulses from all parts of the body and relays them to specific cerebral areas

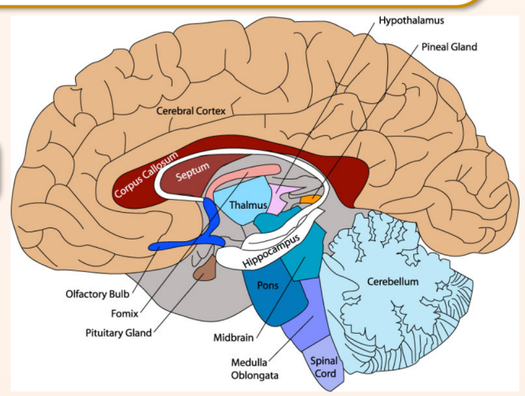
Hypothalamus

- Controls **autonomic nervous system functions**
- **Regulates**

1. *Body temperature*
2. *Water balance and metabolism*
3. *Secretion of anterior pituitary gland*

Midbrain

- **Connects** cerebrum to cerebellum and pons
- Concerned with **motor coordination**



Hindbrain

Cerebellum

Maintains **body posture and equilibrium**

Pons

- **Connects** cerebellum to medulla oblongata
- Contains **"Locus cerulus"**

Medulla oblongata

- **It is the link between brain and spinal cord**
- **Contains many vital centers such as:**

1. *Respiratory center*
2. *Cardioinhibitory center (CIC)*
3. *Vomiting center (CTZ = Chemoreceptor trigger zone)*
4. *Vasomotor center (if inhibited circulatory collapse)*

Spinal cord

- Cylindrical mass of nerve cells
- Extended from medulla oblongata to lower lumbar vertebrae
- *Passes impulses from and to brain*

CNS Systems

Pyramidal system

- Originates from the motor area of the cerebral cortex and passes to the spinal cord so called "corticospinal tract"
- Regulates *fine* voluntary movements

Extrapyramidal system

- Controls the motor functions but involves areas other than those of the pyramidal system
- Regulates **GROSS** voluntary movements
- **Basal ganglia** is part of this system
- ***Keep in mind*** *.. degenerative changes in the pathway running from substantia negra to corpus striatum (Nigrostriatal pathway) may cause parkinson's disease (tremors + skeletal muscle rigidity)*

Limbic system

- **It contains**

1. *Thalamus*
2. *Basal ganglia*
3. *Hippocampus (short-term memory)*

- Controls *behavior* and *emotions*

Reticular formation

- Reticular activating system
- Network of nerve fibers and neurons starting from the upper part of the spinal cord and extending upwards to cortex
- It includes **"locus cerulus"**
- Controls **consciousness** and **wakefulness**

Tuberohypophyseal system

- Group of neurons running from the hypothalamus to the hypophysis (pituitary gland)
- Regulates ***pituitary gland secretion***

CNS Neurotransmitters

Biogenic amines

Acetylcholine (Ach)

- Widely distributed in CNS at cholinergic neurons at:
Motor area - Cerebral cortex - Corpus striatum - Hippocampus - Spinal cord
- **M_1 receptors** mainly mediate the effect of Ach
- ***Keep in mind ..***
If increased at corpus striatum → Parkinson's disease
If decreased at hippocampus → Alzheimer's disease
- **Functions:**
Arousal - Learning - Short-term memory - Motor activity

Noradrenaline (NA)

- Noradrenergic neurons originate mainly at the **pons** from **locus cerulus** and reticular formation
- *High NA in brain →* ***wakefulness and alertness***
- *Low NA →* ***mental depression***
- **Functions:**
- ***Arousal, Mood and blood pressure regulation***

Histamine

- Small amounts of histamine are present in CNS
- Its neurons originate from **small regions in hypothalamus**
- **Its receptors in CNS: H_1 , H_2 & H_3**
- **Involved in:** ***Emesis*** ***(so notice that ..*** *most H_1 blockers are associated with antiemetic effects* ***)***

Dopamine (DA)

- **Dopamine can act as:**
1. **Precursor of NA** at noradrenergic neurons where dopamine β-hydroxylase enzyme is present
2. **Neurotransmitter** in dopaminergic neurons as there is no enzyme
- **Dopaminergic receptors are 2 types: D_1 , D_2** → G-Protein coupled receptors *(involve adenylate cyclase / cAMP system)*

- **Dopamine is a neurotransmitter of 3 systems:**
1. **Nigrostriatal system (motor function)**
If DA decreased → **Parkinson's disease** *(notice that there should be a balance between DA and Ach)*
2. **Limbic system (behavior and emotion)**
If DA increased → **Shizophrenia**
3. **Tuberohypophyseal system (endocrine function)**
If DA ⇑ → Growth hormone secretion ⇑ → prolactin hormone secretion ⇓ *(from pituitary gland)*

Notes

- **Upon treatment of schizophrenia** *(by decreasing the action of dopamine)* → Parkinson's- like symptoms will occur *(as DA will be < Ach)*
- Also DA or dopaminergic agonist stimulates CTZ in medulla oblongata causing **nausea and vomiting**

so, dopaminergic antagonists as **metoclopramide (Primpran®)** can be used as antiemetics

Serotonin (5-HT)

- Its neurons originate from **Raphe nuclei** *(in pons and medulla oblongata)*
- **Its receptors in CNS: $5\text{-}HT_1$, $5\text{-}HT_2$ & $5\text{-}HT_3$**
- **Involved in:** ***Mood, Behavioral changes, Hallucination, Sleep/arousal, Sensory transmission control***

Aminoacids

Inhibitory

Glycine

- Present in high concentration in **Spinal cord**
- Its receptors can be competitively blocked by **strychnine** → ***convulsions***
- **Tetanus toxin** ***can prevent Glycine release*** → *Violent muscle spasm, sardonic smile*

GABA

- The **major inhibitory neurotransmitter** in the mammalian CNS
- Present only in **brain tissue** *(abundant in Nigrostriatal pathway)*
- *Synthesized biochemically from glutamate by glutamate decarboxylase*
- **Receptors: $GABA_A$, $GABA_B$**

$GABA_A$

- Channel-linked receptor
- **Mechanism:** if stimulated by GABA → Cl^- permeability increase → hyperpolarization → **sedation and hypnosis**
- **The receptor has 3 sites:**

1. GABA binding site

- *Stimulated by* endogenous GABA and GABA agonists
- *Blocked by* GABA antagonists ex. Bicucullin

2. Modulatory site (Benzodiazepine binding site)

interaction of BDZs with this site → facilitate binding of GABA to its receptor site → increasing inhibitory action

3. Cl^- channel

- if blocked → convulsions → ex. Picrotoxin
- if activated → CNS inhibition → ex. Alcohol

$GABA_B$

- G-Protein coupled receptors
- **Mechanism:** Activation of $GABA_B$ → closes Ca^{+2} channels and opens K^+ channels → inhibition → ***skeletal muscle relaxation***
- *They can be selectively stimulated by* $GABA_B$ agonists ex. Baclofen

Excitatory

Glutamate & Aspartate

- **Receptors:**

1. Ionotropic *(channel-linked)* ***(NMDA receptors)***

2. Metapotropic *(G-protein coupled receptors)*

- When glutamate ⇑⇑⇑ → ⇑⇑⇑ electrical activity → **epilepsy**
- When brain O_2 ⇓ → glutamate level ⇑⇑⇑ → excessive NMDA receptor activation → ⇑⇑⇑ electrical activity which may kill brain neurons in some regions **Excitotoxicity** *(brain cell death)*

Others

Adenosine

- **Receptors:**
A_1, A_2 & A_3 *(G-protein coupled)*
- It is an **inhibitory** neurotransmitter
- **Actions:** Drowsiness, Analgesia
- **A_2 antagonist** → **Caffeine** → ***Arousal, Alertness***

Melatonin

- **Synthesized from 5-HT** in the pineal gland
- **Receptor:** G-protein coupled
- **Action:** It regulates "sleep-wake cycle" *(circadian rhythm) (Biological clock)*
- Its release is synchronized with **darkness**
- **Used to:** control "jet-lag" and to improve performance of night shift workers